Westinghouse Lighting Institute

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GENERAL ILLUMINATION COURSE

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CONTENTS

FLOODLIGHTING

WESTINGHOUSE LAMP COMPANY

ENGINEERING AND TECHNICAL DATA PREPARED
BY THE COMMERCIAL ENGINEERING DEPT. OF THE
WESTINGHOUSE LAMP CO., BLOOMFIELD, N. J.

FLOODLIGHTING

An increasing public interest in historic structures and a growing appreciation of beautiful works of architecture has stimulated the use of floodlighting materially in recent years. Commercial organizations, too, have awakened to the possibilities of this dignified and economical means of attracting attention to their places of business.

In planning exterior lighting, the relatively large areas involved, the influence of surroundings and the effect of weather conditions, necessitate lighting equipment and calculations entirely different from those used in interior lighting. The provision of sufficient illumination of suitable quality and of proper direction, with no objectionable brightness or glare, constitutes an individual problem in almost every instance.

The floodlighting of buildings and monuments is largely a question of aesthetics. Uniform, shadowless lighting often defeats the very purpose of the installation. Shadows are essential to relief, and contrasts in intensity or in color can be used advantageously to bring out important details and to suppress others; however, care must be exercised to see that shadows will not be formed so as to distort the appearance of the structure and produce a grotesque result. The aim should be to light the surface so as to preserve and enhance the architectural features

In the case of outdoor bulletin boards or poster panels, the aim should be to provide a uniform intensity of illumination over the entire surface of the display. Outdoor construction work and industrial yards require ample light at working points and thoroughfares. It is important that long, heavy shadows, which present a constant menace to safety, be avoided. This necessitates that light be received from several directions and from projectors located advantageously about the grounds.

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The Edison Building in Philadelphia, with projectors on the various set-backs lighting the upper floors, illustrates the present trend in the floodlighting of modern commercial structures. A total of 262 KW. in clear and colored light is employed.

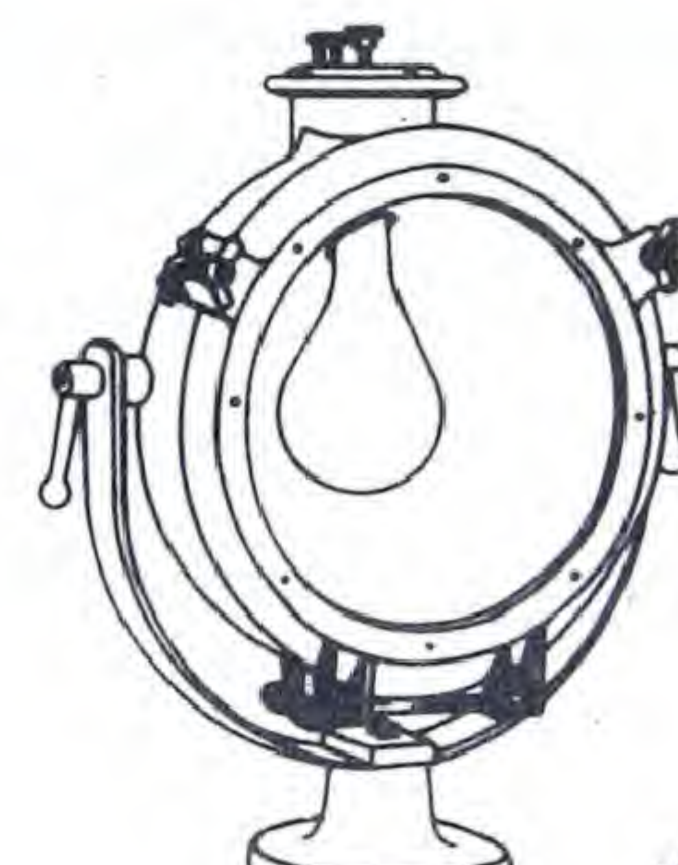
Floodlighting, using twelve 500 watt projectors, enhances the beauty of the Montclair War Memorial and permits its enjoyment at night as by day.

Washington's Headquarters, Morristown, N.J. Five 1000 watt projectors illuminate the front of this historic structure to an intensity of four foot-candles.

Two general types of floodlighting projectors are available: (A) those employing the round bulb floodlighting lamps and (B) those designed to use the standard general lighting service lamps. Some of the latter type can be fitted with adapters which permit the use of either type of lamp. Where a narrow beam (10 to 20 degrees) is desired the 250 or 500 watt round bulb concentrated filament Mazda lamp should be used. For wide beams (20 to 35 degrees) the longer life, less expensive, general lighting service Mazda lamps in the PS bulb, available in 300 to 1500 watts are recommended.

(A)

For still wider beams, the stippled or diffusing glass lenses should be used. There are also available spread lenses of ribbed glass for fanning out the beam in one plane. Where spill light may be a source of glare or detract from the desired result, louvers of concentric or parallel metal bands should be used.



(B)

The increasing demand for color in floodlighting has resulted in the recent development of suitable accessory equipment. Inner lenses of colored glass and also caps fitting over the lamp bulb are now available. In planning installations using color, the transmission factors on page 43 of Assignment 3 should be taken into consideration. While color intensities comparable to those of clear light are unnecessary, allowance should be made for low transmission through screens of the deeper colors and the necessary additional wattage provided.

FLOODLIGHTING DESIGN

The "Lumens in the Beam" method of calculation is now usually employed in designing floodlighting installations. As the name implies, this method is based upon the quantity of light (lumens) directed

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by the projector into the beam. The calculations assume an average intensity over the area to be illuminated. The procedure in designing floodlighting installations by this method is as follows:

1 - Location of Equipment

The location of floodlighting equipment is usually dictated by the physical surroundings. Construction of buildings, topography, area to be lighted and good judgment usually determine the best position for the projectors.

Sometimes a building can be illuminated by placing the projectors on the roofs of other buildings. Where this is possible, best results are usually obtained because the light sources are easier to conceal, the rays strike more nearly perpendicular to the building and the illumination coming from above tends to produce natural shadows.

In plans for new construction, consideration should be given to exterior illumination and provision made for mounting and concealing floodlighting projectors even though their immediate use is not in prospect.

2 - Required Illumination in Foot-Candles

The intensity of illumination required to properly illuminate various types of structures and outdoor areas will be found in the table on page 107 which lists the present standards used in modern practice. The minimum values should be considered as irreducable and those of "Good Practice" employed wherever possible. For spectacular results still higher intensities can be very effectively employed. The table allows for color of surface and brightness of surroundings which obviously must be considered in planning outdoor lighting installations.

3 - Total Amount of Light Required on Object

Having selected the intensity, multiply this foot-candle value by the area in square feet to be illuminated to obtain the total amount of light (total lumens) required on the object.

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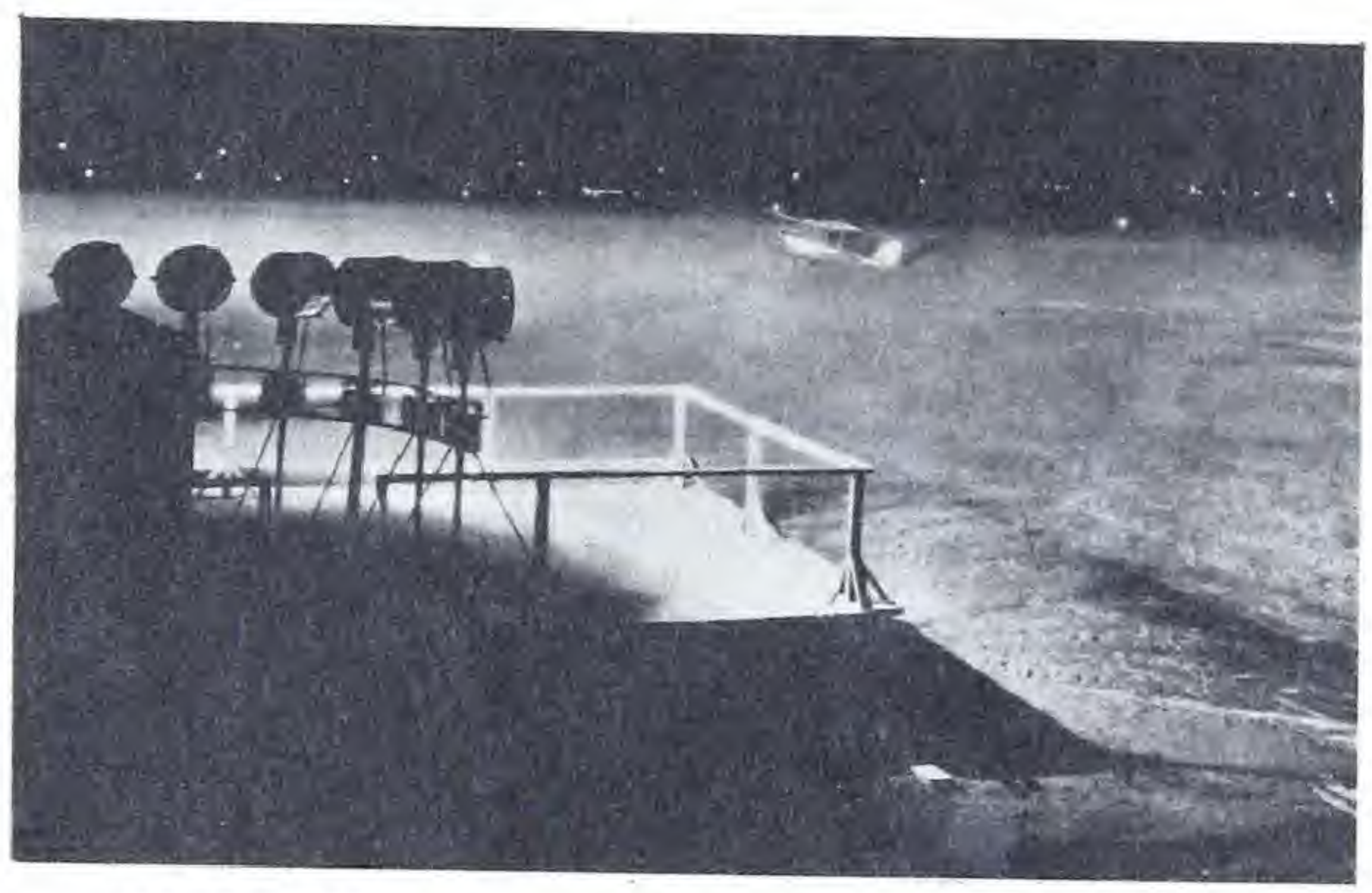
Floodlighting is becoming increasingly popular for advertising industrial plants making nationally known products. The installation illustrated consists of fifty-two 500 watt projectors.



Night flying, which greatly extends the usefulness of the air service, is facilitated by carefully planned illumination of landing fields.

Floodlighting from ornamental street lighting units permits exterior lighting of many buildings otherwise impossible to light because of the difficulty in placing or concealing the floodlight equipment. These units employ a 1000 watt lamp for floodlighting and a 200 watt lamp for illuminating the glass panels of the lantern below the reflector.

4 - Number of Projectors - Size of Lamps

The total number of projectors and the size of lamps to be used are determined by a combination of two factors: (1) the number of projectors necessary to cover the object completely with no unlighted spots and (2) the total lumens required to illuminate the object or area to the desired intensity. Obviously the most economical solution will be the one which uses as large a lamp as is consistent with proper coverage, since this will reduce lamp, projector, installation, and operating costs.

The first step is to determine the portion of the object covered by the beam of a single projector. On page 108 is shown the characteristic spot produced by a floodlight. The following pages list the dimensions and areas of the ellipses for typical beam spreads at various angles and distances of projection. Making due allowance for portions of the light beam which the object does not intercept and providing sufficient overlap for uniformity of illumination, it is possible to determine the minimum number of projectors required.

The various manufacturers' catalogues or data sheets should be consulted for beam lumens: i.e., the total number of lumens in the beam of the projector. Using these figures in the following formula will give the number of units required to produce the desired intensity on the object to be lighted.

$$\text{Number of Projectors} = \frac{\text{Area of Surface in Sq. Ft. to be Lighted} \times \text{Required Illumination in Foot-Candles}}{\text{Lumens in the Beam of One Projector}}$$

If the number of projectors necessary to furnish the desired intensity as determined from the above formula is greater than the number (as determined from the table on pages 109 and 110) to completely cover the structure or area, fewer units using larger lamps should be employed. If the number of projectors obtained from the formula are fewer than the number necessary for coverage, the total quantity of light

would be sufficient but its distribution improper. A greater number of smaller units should be used in such cases.

PRESENT STANDARDS OF FOOT-CANDLE ILLUMINATION FOR OUTDOOR LIGHTING

	Foot-Candles Recommended	
	Good Practice	Minimum
Automobile Parking Spaces	1	0.5
Baseball Diamond (Indoor Game)	10	6
Basket Ball	6	4
Bathing Beaches	1	0.5
Bulletins and Poster Panels:		
Bright Surroundings—		
Light Surface	30	20
Dark Surface	50	30
Dark Surroundings—		
Light Surface	15	10
Dark Surface	30	20
Boxing:		
Seats	3	2
Ring	80	50
Building:		
Construction Work	6	4
Excavation	2	1
Building Exteriors and Monuments—Floodlighted:		
Bright Surroundings—		
Light Surface	10	6
Dark Surface	20	15
Dark Surroundings—		
Light Surface	6	4
Dark Surface	12	8
Church Windows (Art Glass)	25–50	15
Circus:		
Seats	3	2
Arena	10	6
Clock Golf	10	6
Croquet	6	4
Dredging	2	1
Drill Fields	3	2
Flags—Floodlighted	25—50	15
Football:		
Practice	6	4
Games	12	8

	Foot-Candles Recommended	
	Good Practice	Minimum
Gasoline Filling Stations:		
At Pumps	15	10
Yard and Driveways	4	2
Horseshoe Pitching	6	4
Ice Hockey	8	5
Loading Docks	3	2
Lumber Yards	1	0.5
Motordromes:		
Seats	3	2
Track	15	10
Monuments (See Building Exteriors)		
Piers:		
Freight (See Loading Docks)		
Passenger	4	2
Playgrounds	4	2
Polo	8	5
Prison Yards	3	2
Protective—Industrial	1	0.5
Quarries	3	2
Railway Yards:		
General	0.25	0.15
Scale House	3	2
Roque	6	4
Signs—Painted (See Bulletins)		
Ship Yard Construction	6	4
Skating	2	1
Storage Yards	1	0.5
Swimming Pools	5	3
Target Shooting	20	15
Tennis Court	25–50	15
Toboggan Slides	2	1
Traffic Officers	20	10
Trap Shooting	15	10
Volley Ball	15	10

FLOODLIGHT CALCULATION DATA

The beam of a floodlight projector is conical in form. When intercepted by a surface perpendicular to the axis of the beam, the spot of light produced will be circular. Usually, however, the projection is not perpendicular and as a result the area lighted takes on the shape of an ellipse. At greater angles of projection (Ø) than shown on the following page, the spot will obviously be a longer ellipse. At grazing angles the intensity of illumination will be

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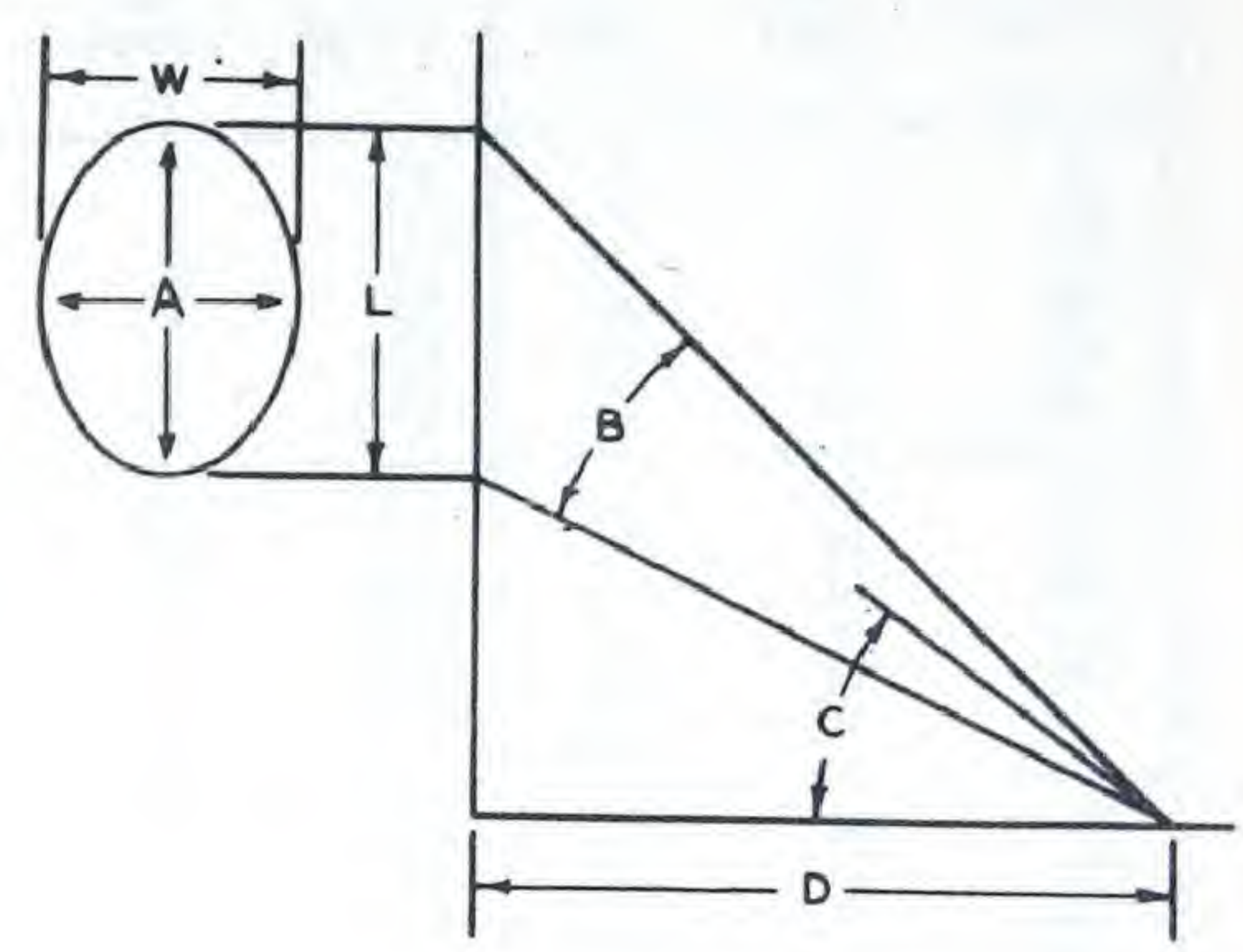
considerably higher on the portion of the lighted area nearest the projector.

The table on the following pages gives the length, width, and area of the illuminated spot for various beam spreads, distances, and angles of projection. In most cases data may be obtained directly from the table. Where beam spreads (B) and angles of projection (C) other than those listed are to be employed it will be necessary to estimate the corresponding information.



In the illustration to the right the length (L) and width (W) vary directly with the distance (D). The area (A), however, varies with the square of the distance (D). Thus, for any distance not listed in the table on the following pages, data on the length and width of the ellipse may be obtained by direct proportion from the data given for any other distance with a projector of the same beam spread and the same angle of projection. The area of the ellipse at any given distance will be in proportion to the square of the distance (D) from the point of projection and can be calculated accordingly.

The data in the following table apply to projectors equipped with clear glass lenses which are usually employed for floodlighting purposes. Projectors with lenses spreading the beam in one direction give smoother illumination and greater coverage for floodlighting structures or areas of relatively narrow proportions.

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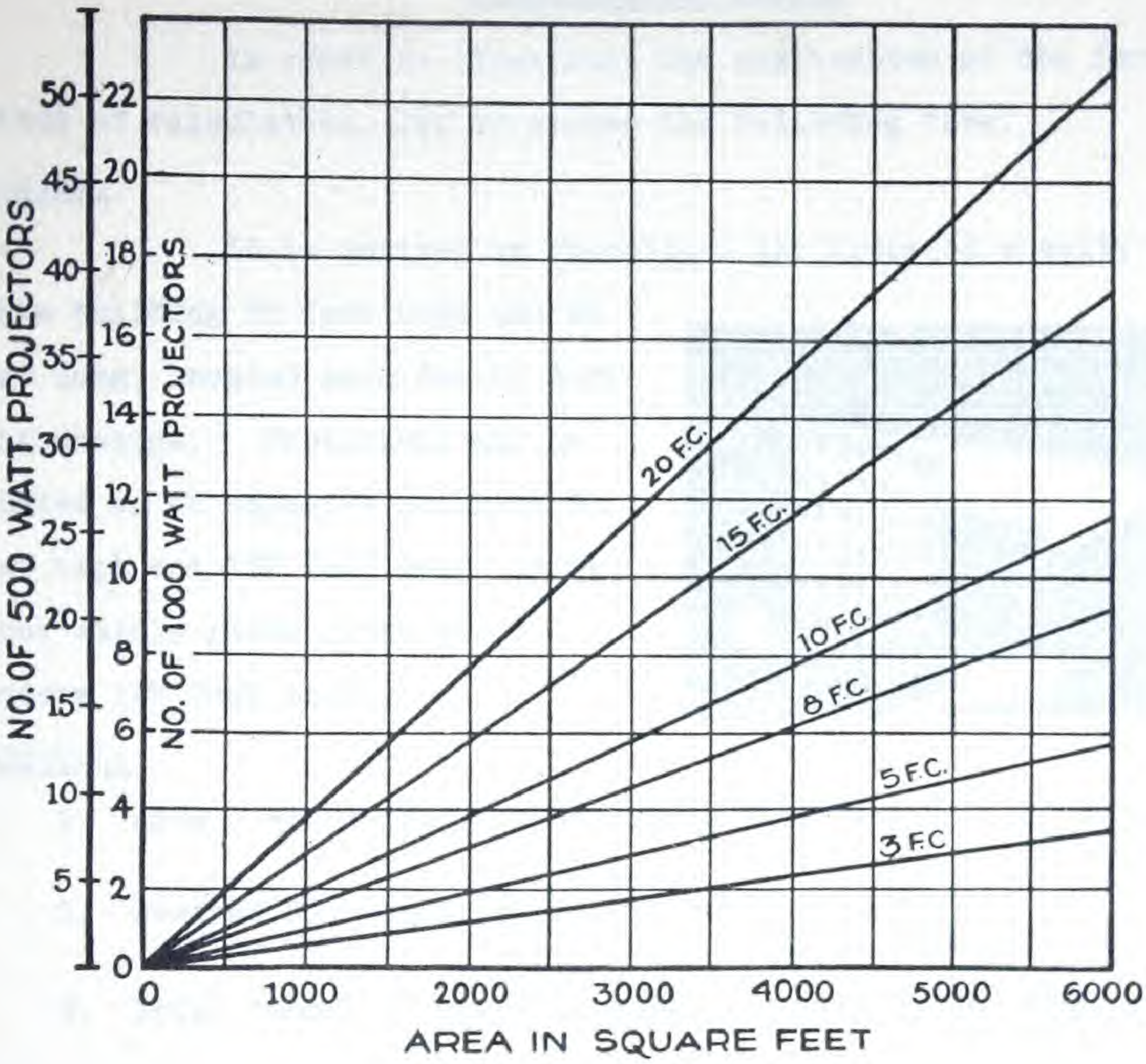
FLOODLIGHT CALCULATION DATA

		B = 10°			B = 15°			B = 20°		
D Ft.	C Deg.	L Feet	W Feet	A Sq. Ft.	L Feet	W Feet	A Sq. Ft.	L Feet	W Feet	A Sq. Ft.
25	0	4	4	15	7	7	34	9	9	61
	15	5	5	17	7	7	37	9	9	68
	30	6	5	23	9	8	53	12	10	95
	45	9	6	43	13	9	99	18	11	181
	60	18	9	124	28	14	297	39	19	566
	75	73	18	1028	130	29	2950	232	45	8251
50	0	9	9	59	13	13	135	18	18	244
	15	9	9	66	14	14	151	19	18	271
	30	12	10	93	18	15	210	24	20	382
	45	18	12	172	27	19	398	36	23	724
	60	36	18	494	56	27	1184	78	37	2263
	75	146	36	4120	259	58	....	464	91	....
75	0	13	13	135	20	20	308	26	26	549
	15	14	14	149	21	20	336	28	27	609
	30	18	15	207	26	23	473	36	31	859
	45	26	19	385	40	28	893	55	34	1629
	60	54	26	1112	83	41	2660	117	56	5091
	75	220	54	9280	389	87	....	696	136	....
100	0	18	18	240	26	26	543	35	35	977
	15	19	18	264	28	27	607	38	36	1082
	30	23	20	371	35	31	845	48	41	1528
	45	35	25	685	54	38	1590	73	46	2896
	60	72	35	1987	111	54	4725	156	74	9050
	75	292	72	16480	518	116	....	929	181	....
150	0	26	26	538	40	40	1225	54	54	2280
	15	28	27	598	42	41	1360	57	55	2435
	30	35	30	835	53	46	1905	71	61	3430
	45	53	37	1542	80	57	3570	109		6515
	60	107	53	4460	167	82	....	233	111	....
	75	438	107		778	174	....	....	278	....
200	0	35	35	957	53	53	2180	71	71	3900
	15	38	36	1067	57	55	2420	76	73	4330
	30	47	40	1480	71	61	3390	95	82	6095
	45	70	50	2750	107	76	6350	146	101	....
	60	143	71	7920	222	108	....	311	148	....
	75	585	143	....	....	232	....	....	370	....
300	0	52	52	2155	79	79	4900	106	106	8770
	15	56	54	2400	85	82	5445	113	109	9720
	30	70	61	3345	106	92	7640	143	123	....
	45	106	75	6170	161	113	....	219	152	....
	60	215	106	....	335	163	....	467	223	....
	75	878	215	....	....	348	....	....	557	....
500	0	87	87	5930	131	131	....	176	176	....
	15	94	91	6660	141	136	....	189	182	....
	30	117	101	9260	177	153	....	238	203	....
	45	176	124	....	268	189	....	364	254	....
	60	358	176	....	556	271	....	778	375	....
	75		538	....	....	580	....	....	928	....

FLOODLIGHT CALCULATION DATA—Cont'd

		B = 25°			B = 30°			B = 35°		
D Ft.	C Deg.	L Feet	W Feet	A Sq. Ft.	L Feet	W Feet	A Sq. Ft.	L Feet	W Feet	A Sq. Ft.
25	0	11	11	97	13	13	141	16	16	193
	15	12	12	108	14	14	158	17	16	218
	30	15	13	152	18	16	226	22	19	319
	45	23	16	295	30	20	456	35	23	643
	60	52	24	984	68	30	1623	88	37	2555
	75	525	74	....	...	...	....	...	...	....
50	0	22	22	387	27	27	564	32	32	780
	15	24	23	429	29	28	631	34	33	873
	30	30	26	608	37	31	902	44	37	1263
	45	47	32	1179	59	40	1825	70	47	2580
	60	104	48	3930	137	60	6490	180	75	....
	75	...	148	....	...	...	....	...	...	....
75	0	33	33	866	40	40	1269	47	47	865
	15	36	35	973	43	42	1419	51	49	1963
	30	45	39	1370	55	47	2030	65	56	2840
	45	70	48	2650	89	61	4107	105	71	5815
	60	156	72	8860	205	91	....	270	113	....
	75	...	222	....	...	...	....	...	...	....
100	0	44	44	1540	54	54	2256	63	63	3115
	15	48	46	1723	58	56	2522	68	65	3490
	.30	60	52	2440	73	63	3609	87	74	5060
	45	93	64	4720	119	81	7301	140	94	....
	60	208	96	....	273	121	....	359	151	....
	75	...	296	....	...	...	....	...	...	....
150	0	67	67	3480	80	80	5070	95	95	7020
	15	72	69	3875	87	84	5670	102	98	7850
	30	90	78	5480	110	94	8140	131	111	....
	45	140	97	....	174	118	....	210	141	....
	60	312	145	....	410	183	....	539	227	....
	75	...	444	....	...	...	....	...	...	....
200	0	89	89	6180	107	107	9030	126	126	....
	15	96	92	6910	116	111	....	136	131	....
	30	120	103	9740	147	125	....	174	148	....
	45	186	129	....	231	157	....	280	187	....
	60	417	193	....	547	244	....	718	302	....
	75	...	592	....	...	...	....	...	...	....
300	0	133	133	....	161	161	....	189	189	....
	15	143	138	....	173	167	....	204	196	....
	30	180	155	....	220	184	....	261	222	....
	45	280	193	....	347	236	....	420	281	....
	60	624	289	....	820	366	....	...	453	....
	75	...	888	....	...	...	....	...	...	....
500	0	222	222	....	268	268	....	315	315	....
	15	238	230	....	289	278	....	340	327	....
	30	300	258	....	366	313	....	435	371	....
	45	466	322	....	578	393	....	700	468	....
	60	...	482	....	...	608	....	...	754	....
	75				...	...	....	...	...	....

HANDY FLOODLIGHTING CALCULATION CURVES



The above curves, calculated by the "Lumens in the Beam" method, are based upon 26 per cent of the total lamp lumens being directed into the projector beam. This is an average value typical of floodlighting equipment now commercially available. The curves are intended to serve as a convenient check on calculations or for use in quickly determining the approximate number of floodlighting units necessary to illuminate a given area to a given intensity. The table on pages 109 and 110 should be consulted to insure adequate coverage of the surface by the projector beams.

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EXAMPLE

FLOODLIGHTING DESIGN

In order to illustrate the application of the foregoing method of calculation, let us assume the following case:

Problem:

It is desired to floodlight the front of a white terra cotta building 75 feet high and 80 feet long, located amid fairly dark surroundings. Projectors may be located on an opposite building 50 feet high and 150 feet away. First floor mainly plate glass store windows (15 feet high).

Solution:

1. Area - exclusive of plate glass windows = 60 x 80 = 4800 sq. ft.

2. Desired foot-candles (lumens per square foot) (Table, page 107) = 5

3. Total lumens on building (Item 1 x Item 2) = 4800 x 5 = 24,000

4. By plotting the layout to scale, it will be seen that the light rays strike approximately perpendicular to the building surface (angle of projection (c, page 108) equals zero) and from page 110 three projectors, each having a beam spread of 25°, cover the building with generous overlaps.

   Referring to one manufacturer's catalogue, the lumens in the beam of a 25° projector using a 1000 watt Mazda C lamp are 5,500. Dividing 24,000 lumens, the total quantity of light required, by 5,500, the lumens in the beam of one projector, gives 4.4. Therefore, five 1000 watt projectors will be necessary to provide the illumination desired.

As only three projectors having a 25° beam are necessary for complete coverage, the building should be uniformly illuminated in view of the additional equipment used to provide the desired intensity.

The installation should, therefore, consist of five 1000 watt projectors having a 25° beam spread and located on the roof of the opposite building.

QUESTIONS

1. A 20 degree floodlight projector is mounted on a tower, 75 feet above the ground. When directed 30 degrees below the horizontal what will be the dimensions of the spot and the area of the ground illuminated?

2. What conditions determine the foot-candle intensity to be provided in lighting building exteriors or monuments?

3. What determines the size of lamp and the number of projectors necessary for a floodlight installation?

4. List ten applications of floodlighting.

5. What are the advantages of floodlighting: (a) office building; (b) industrial plants; (c) monuments?

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